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Progress and Trend Analysis of Green Building Research from the Perspective of CiteSpace

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Abstract

Green buildings, as an important way to achieve sustainable development, have received widespread attention in recent years. This article uses CiteSpace software to visually analyze the literature on green building research in the Web of Science Core Collection from 2014 to 2024, revealing the research progress and trends in this field. Research has found that green building research mainly focuses on evaluating sustainable development, technical support, environment, and other aspects. In the future, green building research will pay more attention to resident experience, technological innovation, and community participation, in order to promote the development of the construction industry towards a greener, more efficient, and sustainable direction. This article can help readers better understand the current situation and development trends of green buildings, and more easily recognize the shortcomings in the development of green buildings, thus providing a promising direction for future research.

Keywords

Green Building; Trend Analysis; CiteSpace.

1. Introduction

As global climate change and environmental issues intensify, green buildings have gained widespread attention as a key solution for sustainable development. Green building focuses not only on energy efficiency and environmental protection but also on the harmonious relationship between humans and nature throughout a building's lifecycle. Despite different interpretations of the concept globally, its core goals-effective resource use, creating healthy living environments, and promo[1].

With the growing body of research on green buildings, it has become challenging to pinpoint key research areas. Scientometric tools like CiteSpace offer an effective way to analyze development trends in this field. CiteSpace, as a citation visualization software, reveals knowledge structures and evolutionary patterns in scientific literature, helping to identify important research and emerging hotspots. This paper aims to analyze the progress and trends in green building research using CiteSpace, providing insights for future research and practice to support the sustainable development of the industry.

2. Research Method

This study uses CiteSpace software, a scientific graph method, to analyze the progress and trends in green building research. Scientific graphs, defined as the "universal process of domain analysis and visualization," reveal the knowledge structure of a field[2]. Through visualization, they help identify patterns and trends in large amounts of literature, which traditional methods cannot easily achieve. Scientometric analysis combines bibliometric tools and data to analyze literature and identify trends within a field[3]. This study employs this approach, following stages of selecting tools, data collection and analysis, visualization, and presenting the results.

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2.1 Selection of Scientific Atlas Tools

The visualization analysis software CiteSpace used in this article is a system that can detect trends and changes in scientific disciplines over time and visualize them. It can be used to explore fundamental changes from research frontiers to theoretical foundations.CiteSpace is currently one of the most widely used knowledge mapping tools[4]. It can describe the macro structure and future development of the knowledge domain through dynamic graphs with chronological order.This article will use CiteSpace to analyze the theoretical structure, evolution process, research hotspots, and development trends of green building themes from 2014 to 2024, and conduct multidimensional dynamic network analysis.

2.2 Data Collection

To ensure the authority and relevance of the data, we used the Web of Science core collection as the source for analyzing green building research. A retrieval strategy (TS=("Green building*" OR "Green buildings*" OR "Green construction*" OR "Green constructions*")) covered literature from 2014 to 2024, including "Article," "Review," and "Conference Papers" types, limited to "Construction Building Technology" and "Architecture" fields in English. After deduplication and screening, 823 relevant articles were selected. Using CiteSpace software, we visualized and analyzed these to uncover the knowledge structure, research hotspots, and trends, offering insights for future research.

3. Citation analysis Results

3.1 Analysis of Hot Institutions

The collaborative relationships and literature contributions between different institutions in the field of academic research. It can be manifested through institutional network relationships .Using "Institution" as the node type and "Year" as the default cutting frequency, a network diagram of institutional cooperation was obtained, as shown in Figure 1.After analysis, the research papers in this field include 214 research institutions, and the top ten institutions in terms of publication volume are shown in Table 1.From 2014 to 2024, China had the highest number of publications, with 5 out of the top 10 institutions belonging to China, indicating that China's position in the field of green building is gradually rising.Overall, a cluster centered around multiple universities such as Southeast University, Xi'an University of Architecture and Technology, Krakow University of Technology, Istanbul University of Technology, etc. has formed in the picture, and cooperation between international higher education institutions is relatively common.

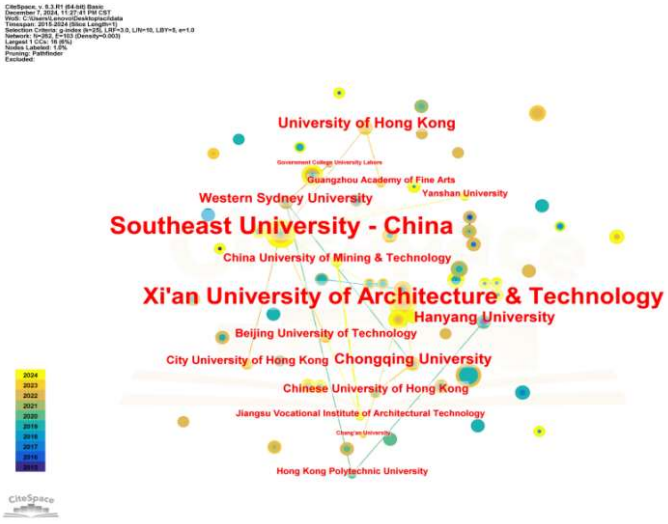

Figure 1. Network diagram of institutional cooperation

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Table 1. Top 10 research institutions with the highest number of publications in the field of green building research from 2014 to 2024

Ranking	Institution	Country	Number of publications/article
1	Southeast University	China	31
2	Xi'an University of Architecture & Technology	China	21
3	Cracow University of Technology	Poland	18
4	Istanbul Technical University	Turkey	17
5	Egyptian Knowledge Bank (EKB)	Egypt	15
6	Michigan State University	United States	10
7	Ariel University	Israel	10
8	Peking University	China	9
9	Tianjin University	China	7
10	Harbin Institute of Technology	China	7

3.2 Keyword Knowledge Graph

1) Keyword co-occurrence network.Keywords reflect the theme and central idea of the literature[5], and the analysis of keywords can reveal the core content of green building research.Therefore, taking the keywords in the literature from 2014 to 2024 as the analysis content, first import the data of wos into CiteSpace software, with network nodes as keywords and one year as the time slice, and export the green building keyword network diagram, as shown in Figure 2.After removing the names of disciplines and commonly used vocabulary such as "Building" (46 times Construction: 38 times) and "Greenbuilding" (32 times Green Building) from the hot keywords, export and organize them into a keyword research hot topic information table (Table 2).For the 30 hot keywords listed in the table, "performance" appears the most frequently, followed by "impact"; The centrality of "sustainability," "technology," and "environment" is the strongest, at 0.15, 0.12, and 0.11, respectively.From this, it can be seen that research on building design with the theme of "green building" mainly focuses on evaluating sustainable development, technical support, and the environment.

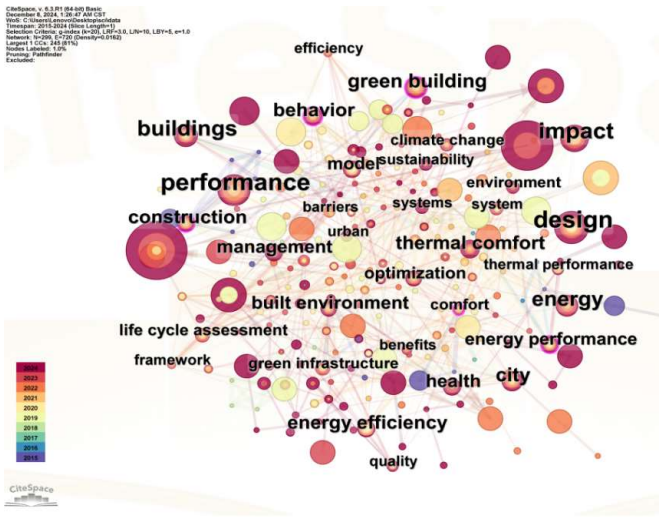

Figure 2. The high frequency keywords of papers

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Table 2. Keyword Statistics Table (Top 30 in Frequency Ranking)

No	Keywords	Freq	Centrality	No	Keywords	Freq	Centrality
1	performance	72	0.07	16	technology	18	0.12
2	impact	69	0.04	17	comfort	16	0.07
3	design	51	0.04	18	system	14	0.03
4	city	41	0.07	19	climate change	14	0.08
5	green building	31	0.05	20	environment	14	0.11
6	thermal comfort	31	0.07	21	sustainability	14	0.15
7	energy efficiency	28	0.09	22	systems	13	0.03
8	behavior	27	0.14	23	benefits	13	0.05
9	built environment	26	0.05	24	thermal performance	12	0.03
10	health	25	0.05	25	framework	11	0
11	management	22	0.09	26	quality	11	0.05
12	energy performance	22	0.03	27	barriers	11	0.03
13	model	22	0.02	28	urban	11	0.07
14	optimization	21	0.03	29	efficiency	11	0.02
15	thermal comfort	19	0.07	30	exposure	11	0.04

2) Knowledge Graph Network Clustering Analysis.Using CiteSpace's default algorithm with the log-likelihood ratio (LLR), keywords were clustered into categories and label extraction was performed. Different clusters represent different knowledge domains, with the same cluster indicating related research fields. The clusters generated in CiteSpace are shown in Figure 5. The largest cluster is labeled 0, and the smallest is 9. As shown in Table 5, the top 10 clusters are listed, all with silhouette values greater than 0.8, indicating significant and reliable results. The top five keyword co-occurrence clusters are: "indoor environmental quality," "green facades," "building information modelling," "green infrastructure," and "mental health."

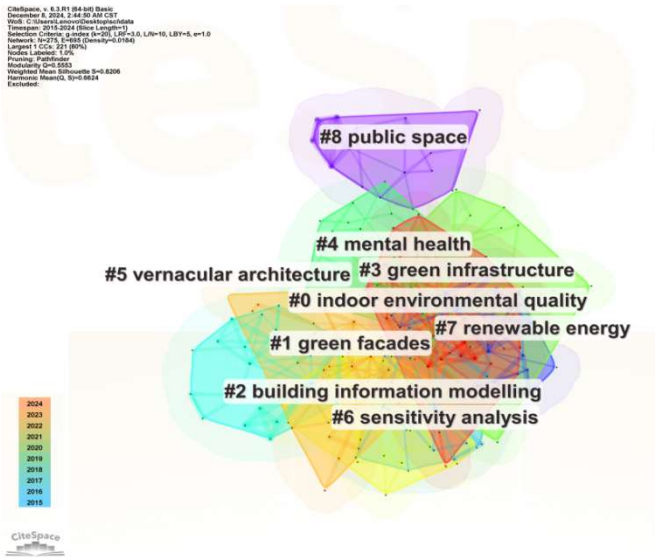

Figure 3. Keyword clustering cluster diagram

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3.3 Keyword Time Zone Analysis

The keyword time zone chart clearly shows the changes in green building research hotspots over time, as shown in Figure 4.Each keyword position in the graph represents the year in which the keyword first appeared in the study time zone, and the lines between the keywords reveal their interrelationships.It is evident from the graph that sustainability, energy consumption, and green building energy efficiency have always been the core focus of research.In recent years, keywords such as comfort, satisfaction level, and management evaluation have gradually attracted the attention of researchers, reflecting that green building research is moving towards a people-centered direction[6]. This trend indicates that research in the field of green building is no longer limited to environmental impact considerations, but is beginning to focus more on the well-being and satisfaction of building users[7]. The emergence of the keywords "comfort" and "satisfaction level" indicates that the field is shifting towards more comprehensive design and operational methods.

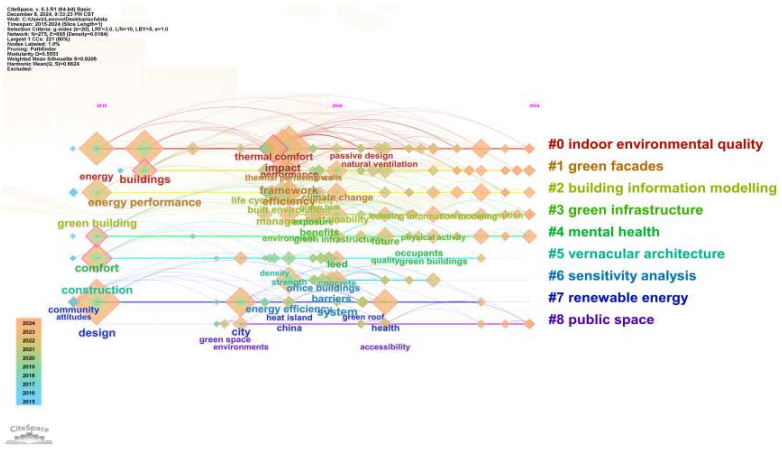

Figure 4. Keyword Time Zone Map

3.4 Analysis of Hotspot Word Emergence

In the quantitative analysis of literature, identifying keywords with strong bursts is very important.By analyzing emergent words, the temporal distribution of keywords can be explored to identify high-frequency and rapidly growing emergent words, thereby exploring the cutting-edge fields and research hotspots of the discipline in each time period . The specific information obtained from analyzing emergent words using CiteSpace is shown in Figure 5.

Top 25 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2015 - 2024
community	2015	2.13	2015	2019	
energy efficiency	2019	3.12	2019	2020	
strength	2019	2.8	2019	2020	
simulation	2019	1.88	2019	2020	
embodied energy	2019	1.86	2019	2020	
building envelope	2019	1.4	2019	2020	
residential buildings	2019	1.4	2019	2020	
durability	2020	2.48	2020	2021	
living walls	2020	2.07	2020	2021	
green facades	2020	2.07	2020	2021	
office buildings	2020	1.69	2020	2022	
mechanical properties	2020	1.65	2020	2021	
green infrastructure	2020	0.92	2020	2021	
temperature	2021	3	2021	2022	
barriers	2020	2.73	2021	2022	
mechanical property	2021	2.24	2021	2022	
nature-based solutions	2021	1.87	2021	2022	
industry	2021	1.49	2021	2022	
green roof	2021	1.49	2021	2022	
indoor environmental quality	2019	1.23	2021	2022	
drivers	2019	0.85	2021	2022	
green buildings	2022	2.56	2022	2024	
occupants	2022	1.46	2022	2024	
benefits	2020	1.23	2022	2024	
leed	2020	1.16	2022	2024	

Figure 5. Analysis of Hotspot Word Emergence

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The strongest word that suddenly appears: "Energy efficiency" is a key focus in green building research, highlighting its central role in the construction industry[8]. It involves reducing energy consumption and optimizing usage, reflecting the sector's concern for sustainability. Improving energy efficiency is crucial for environmental protection and transforming the industry. With the climate crisis, it's a priority in building design, involving high-performance materials, energy-saving systems, and renewable energy. This growing emphasis signals a future where innovation will optimize energy use and reduce environmental impact, driving the industry toward sustainability.

The latest word to appear: resident. As green building concepts evolve, researchers are increasingly focusing on the needs and well-being of residents. This shift reflects a people-oriented design philosophy, prioritizing both environmental sustainability and occupant health and comfort[9]. The emergence of "residents" as a keyword marks a shift in green building research from technological innovation to a broader focus on human living environments. This approach not only considers the environmental impact but also aims to enhance residents' quality of life, driving green buildings toward a more humane, comfortable, and intelligent future.

4. Conclusion

This study conducted a systematic analysis of green building related literature in the Web of Science core database from 2014 to 2024 based on CiteSpace. It comprehensively reviewed the research progress and future trends in the field of green building, revealed the key research directions in sustainable development, technological innovation, and environmental issues, and provided valuable references for promoting the theoretical deepening and practical innovation of green building, which will help to build a more efficient, humanized, and sustainable building environment.

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